

Greenwich Midnight.	Right Ascension.			Decl.	Log. of Dist. from Earth.	Greenwich Midnight.	Right Ascension.			Decl.	Log. of Dist. from Earth.	
1899.	h	m	s	°	'	1899.	h	m	s	°	'	
Mar. 28	12	43	17	N	13 28	0.4707	Apr. 5	12	29	49	N 15 7	0.4630
29	12	41	38		13 41	0.4695	6	12	28	6	15 18	0.4623
30	12	39	59		13 53	0.4684	7	12	26	23	15 30	0.4617
31	12	38	19		14 6	0.4673	8	12	24	40	15 41	0.4611
Apr. 1	12	36	38		14 18	0.4663	9	12	22	56	15 53	0.4606
2	12	34	56		14 30	0.4654	10	12	21	12	16 4	0.4602
3	12	33	14		14 43	0.4645	11	12	19	28	16 15	0.4599
4	12	31	32		14 55	0.4637	12	12	17	43	N 16 26	0.4596

The South Temperate Current of Jupiter, and the Red Spot.
By A. Stanley Williams.

The south temperate current is remarkable above all the other surface currents of *Jupiter* for the uniformity of its motion. This current comprises within its limits the conspicuous belt south of the south equatorial belt, now very generally known as the south temperate belt, and it is from observations of the numerous and prominent spots, and other irregularities of this belt, that we derive most of our information respecting the velocity of its motion. The current, however, is not confined to the south temperate belt. On the north it reaches to the south equatorial belt, whilst on the south its limit varies somewhat from year to year, and even in the same year in different longitudes. Sometimes it extends so far south as to include the dark belt just south of the south temperate belt; whilst occasionally, the more swiftly moving southern current encroaches upon the south temperate current to such an extent that, in certain longitudes, at least, it actually touches the south edge of the south temperate belt. This latter condition occurred, for instance, in 1892, and again in the present year. I have recently made fresh determinations of the velocity of the south temperate current in the years 1881 and 1888, and the results are given below.

1881.

Towards the end of September of this year there was a conspicuous belt visible a little south of the south edge of the red spot, which belt* was not continuous, but ended abruptly in longitude 115°, and the time at which the end of the belt appeared to be in mid-transit was noted upon nine nights.

* It appears uncertain whether this belt is identical with the present south temperate belt, or with a belt just south of the latter. Its approximate latitude, from measures of two drawings, is— $27\frac{1}{2}^{\circ}$. There was a broad, bright interval between the north edge of the belt and the south edge of the red spot.

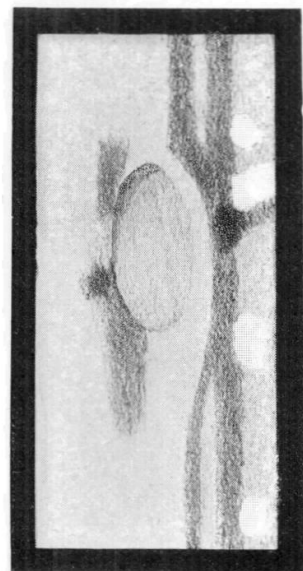


Fig. 1. May 2.

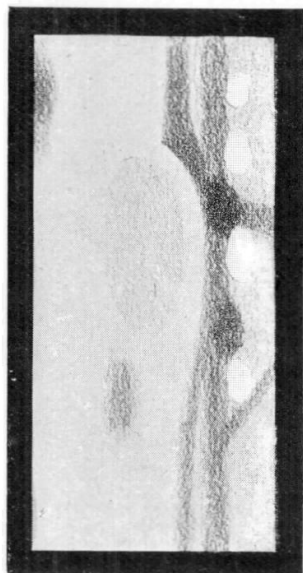


Fig. 2. May 10.

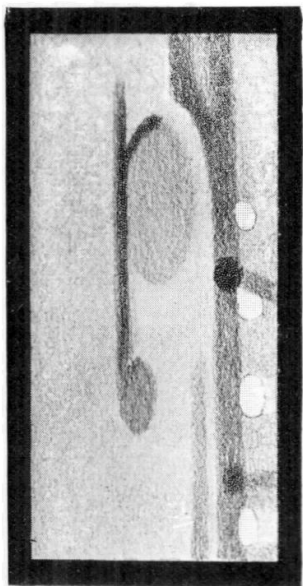


Fig. 3. May 14.

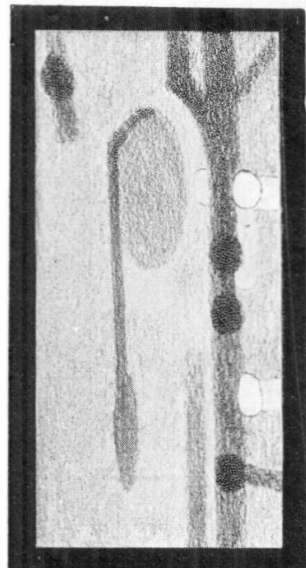


Fig. 4. May 24.

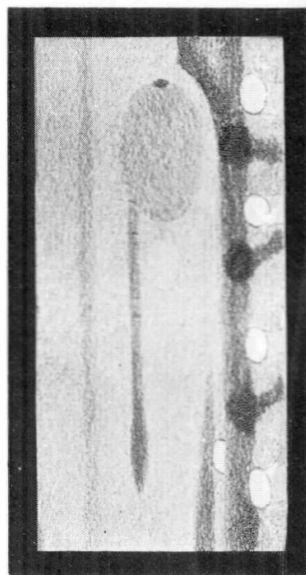


Fig. 5. June 10.

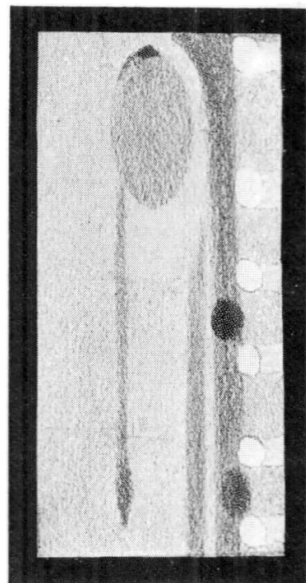


Fig. 6. June 17.

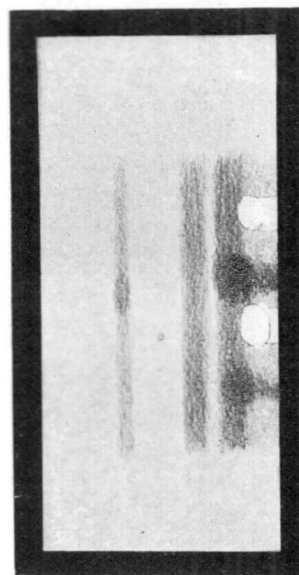


Fig. 7. July 18.

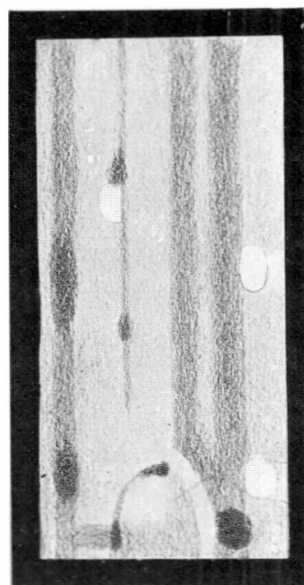


Fig. 8. June 13.

REGION OF THE RED SPOT ON JUPITER IN 1888.

These times were published in the *Observatory*, 1882, p. 112, but as the value of the period of rotation there given is not the correct sidereal period, I have re-discussed the results. The following table contains the observed times of transit of the end of the belt, the longitudes according to the late Mr. Marth's ephemeris in the *Monthly Notices*, vol. xli., p. 364,* and in the last column the residuals O—C, computed with a sidereal rotation period of $9^h 55^m 18^s.3$, which satisfactorily represents the motion of the object.

Date.	G.M.T. of Transit.	Longitude.	O—C.
1881.	h. m.	°	m.
Sept. 29	11 54	115.3	—1.3
Oct. 1	13 32.5	115.9	+1.0
15	14 50	110.2	+0.8
26	8 43	104.4	—1.8
30	11 58.5	104.8	+1.6
Nov. 15	14 51	98.0	+0.9
17	16 25	96.0	—1.1
23	11 18	93.6	—1.3
Dec. 1.	7 50	91.9	+1.1

The observations are very accordant, and show that the motion of the extremity of the belt was perfectly uniform.

1888.

In this year a very remarkable spot made its appearance at the preceding end of the red spot. It is remarkable, not only from its motion, which, as will be seen, was abnormal, but also from its curious appearance and its relationship to the red spot, so that a somewhat full description has been given of its appearance, and the changes that occurred in the course of the observations. As the changes of form might conceivably have affected the spot's apparent motion, it will be best to deal with this part of the subject first.

The first definite appearance of the marking dates from March 25, a drawing of this date showing a prominent dark mass on the sf. side of the red spot. Subsequent observations indicate the presence of much dark material about the south side of the last named object, until when we come to May 2 the appearance was that depicted in fig. 1, plate 1. It is noteworthy that at this time the sp. edge of the red spot was perfectly distinct and regular in outline, notwithstanding the dark markings in apparent contact with it. By May 10 the dark material at the sp. side of the red spot had drifted away from the latter, and now formed a distinct, isolated patch or spot, which was slightly reddish in tint (see fig. 2). Four days later the spot had already drifted a considerable distance farther from the red spot, thus early

* The rotation period of this ephemeris is $9^h 55^m 34^s.47$.

giving indication of an abnormally rapid motion for a spot in this latitude, and had assumed the form of a very regular, well defined, oval spot (fig. 3). A narrow, well defined streak or belt apparently connected the spot with the red spot, and this streak was distinctly seen to cut off and *overlap* the south edge of the latter. This feature was perfectly well determined, for the north edge of the streak was quite sharp, straight, and well defined; whilst the curved outline of the red spot could be distinctly traced as far as the streak but no farther—the southern portion of the curve being cut off by the streak. On May 24 the spot was seen to have lengthened considerably, but its breadth had diminished (fig. 4). On this night again the dark streak or belt was seen distinctly to run in an uninterrupted straight line, and, apparently, to cut off the sudden portion of the red spot. On May 31 it was noted that the dark oval or elliptical spot was now darker in the middle than at the edges, and no reddish tinge could be distinguished. The breadth of the spot continued to decrease, so that by June 10 the marking had assumed the appearance shown in fig. 5, and it now preceded the red spot by a long interval. The spot now also diminished in length, so that by June 17 it was reduced to the dimensions shown in fig. 6. On July 6 it was described as being a mere vestige of what it had been, a mere blackish intensification of the narrow belt, which was visible preceding the spot as well as following it. By July 18 the spot had diminished to the size shown in fig. 7.

The following table contains, as before, the observed times of transit of the marking, the longitudes according to "System II" of Mr. Marth's ephemeris in the *Monthly Notices*, vol. xlviii., p. 68, and the residuals O—C. The third column gives the weights ascribed to the observations at the time, on a scale ranging from 1 (unsatisfactory) to 5 (perfect satisfaction).

Date. 1888.	G.M.T. of Transit. h m	W.	Longitude. °	O—C. m
May 14	13 13	3	306.4	—1.5
21	13 50	1	301.6	—0.2
24	11 20	2	302.1	+4.4
31	11 54	2	295.4	+2.5
June 10	9 52.5	3	285.6	—0.8
17	10 31	3	281.3	+1.1
22	9 28	4	274.7	—3.1
July 6	10 40	2	265.2	—5.5
18	10 24	2	255.3	—1.3
23	9 32	3	254.9	+4.5

The mean period of rotation of the spot, obtained by comparing the first four observations with the last two, is $9^{\text{h}} 55^{\text{m}} 8^{\text{s}}.2 \pm 0^{\text{s}}.40$, and this period appears to satisfactorily represent the

observations, although it is abnormally short, being just 10^s shorter than the average rotation period for this latitude. Since the marking was a long one and underwent great changes, it is conceivable that such changes might have given rise to a fictitious appearance of an unusually rapid drift. For instance, if the decrease in length took place at the f. end alone, the effect would be to make the spot's drift appear to be more rapid than really was the case. But even if the diminution in length had occurred in this manner, this would not nearly account for the whole of the observed difference. Moreover, the observations and drawings confirm the rapid drift, and also rather strongly give the impression of a uniform decrease in length at both ends. On May 31, when the middle of the spot appeared markedly darker than the edges, the darkest part was still at the centre of the marking. The observations of position also show that the motion of the object was uniform between May 14 and July 23, within the limits of ordinary observational errors, and this would disfavour the idea of the change occurring at one end only. It seems impossible therefore to regard the abnormally rapid drift of this spot as otherwise than real.

The remarkably abnormal nature of the motion of the spot will be more apparent if we compare the present determination with others. A list of the principal determinations of the rotation period of the s. temperate current was published in the *Monthly Notices*, vol. lvi., p. 149, and this list is repeated below, with the addition of the two results contained in the present paper.

	^h ^m ^s ^s		
1787	R = 9 55 17.6	250r	Schröter
1862	17.2	128r	Schmidt
1872-3	19.6 ± 2.34	...	O. Lohse
1880	16.2	...	Barnard
1880-I	17.9	...	Denning
1880-II	19.1	...	Barnard
1881	18.3 ± 0.20	152r	Williams
1887	18	55d	Terby
1887	17.1	3s	Williams
1888	8.2 ± 0.40	169r	"
1889	16.7 ± 0.33	263r	"
1889	19.0 ± 0.26	326r	"
1890-I	18.3	1296r	Denning
1891	18.2	53r	"
1891	20	2s	Hough

r = rotation ; *d* = days ; *s* = spots.

The foregoing list also shows clearly the remarkable uniformity in the velocity of this current. The simple mean of the

above values, excluding the 1888 result, is $9^h 55^m 18^s.1$. In no case does an individual result differ by more than $1^s.9$ from this mean, and as a difference of $1^s.9$ in the period of rotation at the latitude of the s. temperate belt corresponds to a difference of 1.3 miles (2.1 kilometres) per hour in the velocity of the current, it follows that the motion of the s. temperate current has not varied by more than 1.3 miles per hour from its mean value during a period of 100 years, so far, of course, as the observations extend. And this small difference includes the observational errors and also local variations, excepting in the case of the second result of 1887. Such a degree of uniformity is, to say the least, very remarkable.

It is probable that the abnormal motion of 1888 was due to some local disturbance, and did not extend right round the planet. The observations of other spots in this latitude are not numerous enough, however, to give any certain information on this point, the considerable south declination of *Jupiter* in this year being very detrimental to obtaining accurate positions of the smaller and fainter spots.

The Red Spot.

Some observations bearing on the relationship of the red spot to a narrow dark streak or belt in 1888 have been detailed above. It may be added that the observations of May 14 and May 24 were both made under fairly satisfactory conditions with a power of 230 on my $6\frac{1}{2}$ inch Calver reflector. On both nights the north edge of the dark streak was well defined, and appeared quite distinctly to cut off the southern part of the red spot. The observations were considered to be quite satisfactory at the time, and to be decisive on this point. Two conclusions may be drawn from this. One is that the streak, or at least the upper part of it, was situated at a higher level than the surface of the spot. The other is that the dark streak was composed of some actual material substance capable of concealing the spot, and was not merely a rift in the bright cloud envelope of the planet.

The last figure on plate 1 has been added on account of the unusual amount of detail shown about the red spot. Definition being good all the details shown were seen distinctly. These consist of a dark border to the sf. edge of the spot; a dark spot at the f. tip; another dark spot on the south edge of the red spot; and a white patch on the surface of the red spot. Rather curiously the dark spot on the south edge was joined to the belt on the south by a dark streak. The red spot was too far past transit when observations were commenced for its preceding half to be well seen.